Raman Spectroscopic Analysis of the Thermal Alteration of Petrified Organic Matter

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Raman spectroscopy is a technique that has received much attention recently in the astrobiological and paleobiological communities. It is a technique for non-destructively analyzing carbonaceous matter *in situ* and therefore lends itself to the examination of delicate and precious samples, such as those of organisms from ancient Earth or of extraterrestrial origin returned to Earth in the future. This study, one that examines the thermal alteration of the chemistry of petrified organic matter, helps to refine our understanding of fossilization and to better understand those more delicate and precious specimens. Using Raman spectroscopy, the organic chemical makeup of a fossil fern species, *Dennstaedtiopsis aerenchymata*, from two distinct localities, both of Eocene age, has been analyzed and the sequence of chemical steps that occur during fossilization and subsequent thermal alteration determined via a proxy, artificial maturation of a modern analogue fern species, *Dennstaedtia cicutaria*.

Samples of the modern fern were heated in a closed, anoxic system at 250ºC for lengths of time ranging from 2 to 600 hours. These samples were analyzed on a Raman system using a UV laser source. Results were compared to those obtained under similar conditions from samples of the fossil fern.

Results show that the rate of chemical change was quite rapid at the beginning of the experiment and then slowed with longer periods of heating. The structure changed from mostly polysaccharidic carbon to a mixture of aromatic and aliphatic carbon. Other preliminary studies using nuclear magnetic resonance spectroscopy and pyrolysis-gas chromatography/mass spectrometry confirm these results.